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ABSTRACTS OF PAPERS

Twenty-third Annual Albert L. Tester Memorial Symposium, 5–7 April 1998[1]

The Albert L. Tester Memorial Symposium is held in honor of Professor Albert L. Tester, who, at the time of his death in 1974, was senior professor of zoology at the University of Hawai'i at Mānoa. The faculty and students of the Department of Zoology proposed an annual symposium of student research papers as a means of honoring, in a continuing and active way, Dr. Tester's lively encouragement of student research in a broad range of fields in biology. Papers reporting original research in all aspects of biology, solicited from graduate students at the University, are presented at the spring-semester symposium. Income from contributions to the Albert L. Tester Memorial Fund of the University of Hawai'i Foundation provides two prizes for the best papers. Judges include representatives of the Department of Zoology faculty, winners from the preceding symposium, and a distinguished scholar from another university, who also presents a major symposium address. In 1998 Kenneth Storey, Professor of Zoology, University of Toronto, Canada, participated in the Symposium.

Comparison of Animal Decomposition in an Intertidal Zone and in a Terrestrial Habitat on Coconut Island, Hawai'i

JOSEPH B. DAVIS[2]

Decomposition is the natural process of recycling nutrients back to the environment. Insects (primarily Diptera and Coleoptera) play a major role in the decomposition process in a terrestrial environment, and marine scavengers are the primary decomposers in a marine environment. The study focused on the intertidal zone, where marine and terrestrial faunas overlap. The animal models were two domestic pigs (*Sus scrofa*). We placed the carcass of one animal directly in the intertidal zone and the other above the intertidal zone. The carcass placed *above* the intertidal zone exhibited decomposition patterns associated with a terrestrial environment—predictable arthropod succession of Diptera as the initial primary colonizers, followed by Coleoptera. The arthropods associated with the carrion were not as diverse as arthropods associated with other decomposition studies on the island of O'ahu. No marine scavengers were found on the carrion. The carcass placed *directly in* the intertidal zone decomposed at a rate of biomass removal similar to that of the carcass placed above the intertidal zone. However, insect colonization did not occur. Instead, wave action, tidal fluctuations, and bacterial activity were primarily responsible for decomposition. Marine scavengers were present; however, their role in decomposition was minimal. The study demonstrated clear differences between animal decomposition patterns in the intertidal zone and in the terrestrial area above the intertidal zone.

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[2] Department of Entomology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: M. Lee Goff.

Genes That Induce Apoptosis: Transcriptional Regulation in Doomed Neurons[3]

TROY A. DRAIZEN[4]

In all organisms, programmed cell death (apoptosis) plays a crucial role in nervous system development. Mechanisms by which cells are eliminated involve a collaboration between both gene expression and developmental cues. Developmental cues such as hormone titers, synaptic contacts, and trophic factors must, in some way, regulate the expression of genes that either induce or inhibit apoptosis. Elucidating the molecular pathways of cell death in the vertebrate nervous system is problematic because of its complexity and lack of markers that identify doomed neurons. The fruit fly *Drosophila melanogaster* offers a less-complex nervous system in which two distinct sets of doomed neurons have been identified. One set, the Type II neurons, are identifiable before their death because they express high levels of the A-isoform of the ecdysone receptor (EcR-A). Anti-EcR-A antibodies allow these doomed neurons to be detected using standard techniques. To determine the molecular pathway by which these neurons die, transcript accumulation from apoptosis-inducing genes was evaluated. In *Drosophila*, three genes, *head involution defective (hid)*, *grim*, and *reaper*, each have the ability to independently induce apoptosis. Before the onset of apoptosis, the Type II neurons accumulate transcripts of both *grim* and *reaper* but not *hid*. These data suggest that in vivo the cooperative action of these genes is used to control programmed cell death.

The Endemic Hawaiian Sap Beetles (Coleoptera: Nitidulidae): Distribution, Ecological Shifts, and Adaptation[5]

CURTIS EWING[6]

The Hawaiian Islands are home to a very disharmonic flora and fauna. The absence of many widely distributed families of plants and animals has allowed some of the chance colonists to speciate spectacularly. The endemic Hawaiian sap beetles are one of those groups and are not only speciose but occupy a wide variety of niches. There are species that exploit nearly every resource described for the family as a whole. The family Nitidulidae comprises ~2500 species, with over 160 found only in Hawai'i. Of these all but six are the result of a single colonization event. They are common in rain forest habitats and to a lesser extent in mesic communities. Very little was known about their distribution, host plant affinities, phylogenetic relationships, and the possible adaptive shifts that have produced the current diversity . To understand the role of the ubiquitous beetles I conducted a survey of appropriate habitats on all the main islands except Lāna'i. I collected and determined host plant associations for over 75 species of endemic nitidulids. They are found on 31 native plant genera in 21 families. There are species that utilize flowers, fruit, exuded sap, and decaying leaves, bark, and stems. A phylogenetic hypothesis has been generated using 433 bp of mtDNA (cytochrome oxidase I). Combining

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[4] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: Steven Robinow.

[5] Supported by a research grant and fellowship from the Evolution, Ecology, and Conservation Biology Program.

[6] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: Rosemary Gillespie.

the phylogenetic framework with data on habitat preference has revealed interesting patterns in resource use. I also identified a pattern of parallel ecological shifts producing parallel morphological changes. This pattern provides a system to investigate questions of speciation, selection, and adaptation to a new niche.

Lipopolysaccharide-Induced Apoptosis in the Symbiotic Light Organ of the Sepiolid Squid *Euprymna scolopes*[7]

JAMIE S. FOSTER[8]

The role of bacteria in the initiation of apoptosis in animal tissues has primarily, if not exclusively, focused on pathogenesis. In contrast to the previous studies on bacteria-induced apoptosis, evidence is presented for the induction of apoptosis in a cooperative association between the sepiolid squid *Euprymna scolopes* (Berry) and the luminescence bacterium *Vibrio fischeri*. In this model system, the symbiotic bacteria induce developmental changes in the morphology of the squid light organ mediated in part by apoptosis. Extended on either side of the juvenile light organ is a ridge and two appendages composed of epithelial cells covered with fields of cilia. The ciliary beat of these structures facilitates the initiation of the symbiosis by circulating bacteria-rich water in the mantle cavity. The symbiotic bacteria enter the light organ through pores on the surface of the light organ, taking up residence in epithelial-lined crypt spaces. Once inside the light organ the bacteria initiate a program of apoptosis in the remote cells of the now-defunct ciliated fields. I examined the effects of the bacterial surface compound lipopolysaccharides (LPS) isolated from the symbiont *V. fischeri* as well as commercially available LPS derived from pathogens known to initiate apoptosis. Preliminary results indicate that exogenous LPS from a variety of gram-negative bacteria including the symbiotic *V. fischeri* are able to initiate a program of apoptosis in the squid light organ. This interaction between the bacterial LPS and host animal cells may be the initial trigger of the apoptotic event. This is the first reported induction of apoptosis in animal cells by a benign cooperative bacterium.

Origins of the Hawaiian Crab Spider Fauna[9]

JESSICA E. GARB[10]

The Thomisidae, commonly known as crab spiders, is one of the few spider families containing genera that are known to be exceptionally diverse in the Hawaiian Archipelago. This diversity led early systematists to place the 21 described Hawaiian species in several unrelated genera. However, recently it has been suggested that these species constitute a large radiation descended from a single colonization event. My research focused on understanding whether the tremendously di-

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[8]Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: Margaret McFall-Ngai.

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[10]Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: Rosemary Gillespie.

verse and confusing morphology found across these Hawaiian species is the result of a single colonization event followed by extremely rapid speciation. I examined the origin of the Hawaiian species using molecular phylogenetic techniques. A 505-bp region of the mitochondrial gene cytochrome oxidase I was amplified and sequenced from 14 Hawaiian thomisid species as well as eight outgroup species. Analysis of these sequences using maximum likelihood methods suggests that the Hawaiian thomisids have descended from at least two separate colonization events. However, the 14 Hawaiian species sampled are not closely related to the genera to which they were originally assigned. Sequence divergence across the Hawaiian species is low, indicating that extensive adaptive speciation within the Hawaiian Islands may account for much of the diversity of their crab spider fauna.

Role of Alien Tree Plantations in Native Forest Restoration in Hawai'i[11]

JENNIFER GARRISON[12]

Alien tree species are often planted to speed forest restoration on degraded lands. Although many researchers have investigated the short-term effectiveness of rehabilitating degraded lands using alien tree plantations, there is little information about the long-term ecological effects of these plantations. I investigated some of the ecological effects of ca. 60-year-old *Eucalyptus robusta* Sm. (Myrtaceae) and *Grevillea robusta* A. Cunn (Proteaceae) plantations on native forest restoration on O'ahu by measuring differences between native forest, *E. robusta*, and *G. robusta* plantations in the (1) physical environment (soil pH and nutrients, leaf litter depth, light levels); (2) plant communities (vegetation structure, fruit availability, species diversity and abundance); (3) seed dispersal (dispersal mechanisms, species diversity and abundance); (4) native plant establishment (germination success, seedling growth rates); and (5) bird communities (proportions of alien and native birds, species diversity and abundance, foraging guilds, movement patterns). The plantations differ in several ways. *Eucalyptus* plantations have a deeper litter layer than *Grevillea* plantations, and, conversely, *Grevillea* plantations have a higher percentage ground cover, made up of mainly alien species. Seedling densities decrease with increasing litter depth. Possibly as a result of this relationship, *Eucalyptus* plantations have fewer seedlings than *Grevillea* plantations. Unfortunately, native plant diversity is quite low in both plantation types, and alien plants are abundant. The low native diversity and heavy infestation of alien weeds does not bode well for the future recovery of native plants in this area. Part of my future research will be to determine if the low native species diversity in these plantations is due to low seed dispersal into the plantations or if the seeds are being dispersed there but are unable to germinate for some reason.

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[12] Department of Zoology and Evolution, Ecology, and Conservation Biology Program, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: Sheila Conant.

Solar Orientation and Visual Capabilities of *Nerita picea* during Summer 1998 at Sandy Beach, O'ahu, Hawai'i[13]

LUCIA MURIEL GUTIÉRREZ[14]

The objective of this study was to assess the existence of solar and visual orientation of the intertidal prosobranch mollusk *Nerita picea* (Récluz, 1841), which is abundant on the rocky shorelines of O'ahu, Hawai'i. Individual snails were tested on Plexiglas disks at Sandy Beach and both sunlight (with and without UV light) and artificial black and white visual cues were tested as exogenic factors that may act on *N. picea* to provide orientation information. Orientation was monitored as a magnetic compass was placed above the anterior end of each snail and bearing in regard to 0° N was recorded. Results showed that *N. picea* had a preferred north and southwesterly orientation during morning hours (away from position of the sun); thus these snails were photonegative. Snails crawled faster in the absence of UV light and in darkness. *Nerita picea* demonstrated skototaxis when given a choice of white and black boards. Among the behavioral adaptations developed by intertidal invertebrates, including gastropods, many orientation mechanisms are light-compass reactions due to spatial and temporal variation of the sun. It seems that *N. picea* uses sunlight as primary compass information over time in combination with perception of stimuli by eyes and/or extraoptic structures, along with the well-known adaptations of tidal rhythmic activity patterns and nonrandom distribution on the shore.

Molecular Mapping of QTLs Conferring Resistance to Maize Streak Virus[15]

XIAOWU LU[16]

Maize streak virus (MSV) causes a major disease of maize in Africa. The objectives of this study were to determine the genome positions of quantitative trait loci (QTLs) conferring resistance to MSV and to estimate the genetic effect of the QTLs. Tzi17, a tropical maize inbred with general resistance to MSV, was crossed to a susceptible tropical maize, inbred Hi34, and 110 recombinant inbred lines (RILs) were produced by single seed descent without selection. The RILs were genotyped with 116 restriction fragment length polymorphisms (RFLPs) and four simple sequence repeats (SSRs). The same population was also evaluated for resistance to MSV under natural infection in winter 1992 and winter 1993 at IITA, Nigeria. The location of QTLs conferring resistance to MSV on the linkage map of maize was analyzed using Mapmaker/QTL (1.1), and QTL Cartographer (1.12e) software. RFLP markers were shown to link to a major QTL conferring resistance to MSV on chromosome 1. The interval between RFLP markers asg30 and umc167 explained around 63% of the phenotypic variance with LOD score as 6.0. A minor QTL for resistance to MSV was

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[14] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: Christopher Womersley.

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[16] Department of Horticulture, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Advisor: James L. Brewbaker.

also identified and mapped on chromosome 9 through the composite interval mapping method with a LOD score of 3.0, in the flanking region between marker umc113 and marker bn18.17. Marker-assisted selection can be incorporated in the breeding program using the flanking markers around the major QTL, as designated *msvl* in this study.

The *cribraria* Conundrum: Untangling a Species Complex in the Cypraeidae (Mollusca: Gastropoda)

FABIO MORETZSOHN[17]

The *Cribrarula cribraria* species complex in the gastropod family Cypraeidae is a conundrum: there are several apparently closely related taxa, but the species boundaries are blurred. The number of species is controversial, with authors disputing the status of taxa at the specific or subspecific level. The purpose of this ongoing study is to try to define species boundaries in this species complex using three sets of characters: conchological, anatomical, and molecular. This paper focuses on the biogeography of the taxa and the results obtained thus far from conchological studies. The nominal species, *C. cribraria* Linnaeus, 1758, is widespread and variable, ranging from East Africa to the central Pacific. A number of geographical forms have been recognized as subspecies, but they might also be recognized as "good" species. Thus shell characters alone cannot be used to define species in this complex. Other recognized species in the complex have smaller geographical ranges and usually less variation than *C. cribraria*. I currently recognize at least seven groups of shells in this complex. More than 300 specimens of the apparently Hawaiian endemic species *C. gaskoini* (Reeve, 1846) were studied. The most noticeable conchological feature is a bimodal distribution in shell size, which suggests sexual dimorphism. Other workers have found that in the cowries, females usually have a larger and more inflated shell than males. I have confirmed it in 12 specimens dissected, but further work is needed to support this hypothesis.

Differential Gene Expression Regulated by Distension of Human Fetal Membranes[18]

ELIZABETA NEMETH[19]

Fetal membranes form a biomechanical adaptable container and a sterile environment for fetal growth and development. In the last half of pregnancy, the membranes distend in vivo to double their area. It is proposed that this can initiate changes in gene expression, resulting in membrane extracellular matrix remodeling. Overdistension, on the other hand, could lead to excessive changes and a pathological situation, preterm birth. A biological model for this is multiple pregnancies, which have a significantly higher incidence of preterm birth. A device was developed for the bidirectional distension of fetal membrane explants in

[17] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: E. Alison Kay.

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[19] Pacific Biomedical Research Center, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Advisor: Gillian Bryant-Greenwood.

vitro, which confirmed the observations of other workers that stretching the tissue to 2.25 times its surface area for 4 hr significantly increases interleukin-8 (IL-8) protein. An amniotic epithelial cell line (WISH) and whole-thickness fetal membranes were used to study the effect of distension on gene expression. WISH cells grown on silastic sheets were stretched to 1.5 times their surface area for 4 hr and mRNAs were used for suppression subtractive hybridization (SSH), a PCR-based method for identification of differentially expressed genes. Two genes have been identified as upregulated in WISH cells and confirmed by quantitative Northern analysis: IL-8 (25-fold) and pre-B-cell colony enhancing factor (PBEF) (3.3-fold). Forty cDNAs have been identified as potentially upregulated after distension of fetal membranes, and Northern analysis has confirmed upregulation of interferon-stimulated gene encoding a 54kDa protein (ISG-54K) and a novel 9kb cDNA. Other cDNAs are currently being quantitated by Northern analysis to determine the levels of their upregulation by stretch.

Morphological and Molecular Diversity in Hawaiian *Argyrodes* (Theridiidae)[20]

Malia Ana J. Rivera[21]

Endemic spiders of the genus *Argyrodes* (Theridiidae) represent one of many diverse, yet little-known radiations of Hawaiian arthropods. Two distinct species groups within the genus are found in the archipelago, each with very different lifestyles, foraging modes, and morphologies. One group (*A. argyrodes* species group) is characterized by a kleptoparasitic lifestyle, living and feeding in the large sheet webs of another native spider lineage. The other group (*Ariamnes*) is generally free-living. Each species group has a characteristic morphology: the kleptoparasites generally are very small and short-bodied, and the free-living forms generally are larger and long-bodied. Genetic analysis of a 473 base pair region of the mitochondrial gene cytochrome oxidase I (COI) suggests separate colonization events for these two species groups, Analysis of COI also showed that the short-bodied kleptoparasitic *Argyrodes* are genetically relatively divergent, showing up to 9% genetic distance between morphospecies, yet the few species in the lineage have remained rather similar morphologically. The level of genetic differentiation between species also suggests that the group is relatively old. Conversely, COI analysis of the long-bodied group revealed that these solitary forms are much more similar genetically, with only up to 5% genetic distance between species, yet the lineage is much more speciose and exhibits a wide range of morphological diversity. These results suggest that, despite their greater age, the short-bodied kleptoparasitic species have diversified little, possibly as a result of the environmental constraints of their host association. In contrast, the younger long-bodied solitary forms have diversified relatively rapidly in terms of numbers of species and morphology, and may represent a true adaptive radiation driven by the exploitation of new feeding niches.

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[21] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: George K. Roderick.

Risk Sensitivity in Honeybees[22]

MARTIN SHAPIRO[23]

Risk sensitivity is a phenomenon in which a foraging animal prefers one of two foraging options that provide the same mean magnitude of reward but different variance about that average. To test for risk sensitivity in honeybees (*Apis melifera*), subjects were trained in a series of choice experiments with two differently scented feeding targets that differed in variability of sucrose concentration. In experiment 1, honeybees were shown to be risk-indifferent (showed no preference), with one odor constantly providing 20% sucrose and the second odor providing 40% sucrose in half of the trials and water in the remaining. In experiment 2, honeybees were found to be risk-averse (preference for the less-variable alternative), with one odor constantly providing 15% sucrose and the second odor providing 60% sucrose in one-fourth of the trials and water in the remaining. In experiment 3, honeybees were found to be risk-average, with one odor constantly providing 40% sucrose and the second odor providing 20% and 60% sucrose with equal frequency. This was the first case of risk sensitivity in honeybees and the first instance of risk sensitivity in insects with variability in concentration. Although most theories of risk sensitivity have ignored proximal causes of behavior, relying on theories relating reward magnitude to fitness gains, the results presented here were quantitatively on very simple assumptions about the mechanisms of association and choice.

Monogamy and Pair-Bonding in the Butterflyfish *Chaetodon multicinctus*

DAVID A. STRANG[24]

The multibanded butterflyfish, *Chaetodon multicinctus* Garrett, 1863, is monogamous and strongly pair-bonded. It feeds on coral, and male-female pairs defend territories from conspecifics and other corallivores. The presence of monogamy in this species presents a challenge to biologists because traditional explanations for monogamy involve the need for biparental care of offspring. Many authors have attempted to explain the social system of butterflyfish, but few have made the distinction between the selection for monogamy and the selection for pair-bonding. Previous research has shown that when a male *C. multicinctus* is removed from the reef, neighboring males will attempt polygyny. This is never successful because of the dispersed nature of the females and the competition from other males. Therefore, males are constrained to monogamy. Previous research has also shown that males and females show a division of labor, where the males assume a larger role in territorial defense while females feed at higher rates. This increased feeding increases the fecundity of the female, which in turn increases the fecundity of her pairmate. This feeding advantage to the female has been proposed as the selective force favoring pair-bonding in butterflyfish. However, at Kahe Point on O'ahu, *C. multicinctus* did not show this division of labor. Males and females showed no differences in feeding rates or defense rates, so there was no apparent feeding advantage. In addition, territory size was larger, defense rates were lower, the coral cover differed, and pairs did not

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[23] Department of Psychology, Bekesy Laboratory of Neurobiology, Pacific Biomedical Research Center, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: M. E. Bitterman.

[24] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: E. S. Reese.

spend as much time together. It may be that the factors favoring monogamy and pair-bonding in butterflyfish differ across habitats. Under circumstances of high territory competition, a male's assistance in territorial defense may be favored, but at Kahe Point territory competition seems to be less intense and the male's assistance may be of less importance. Because of the larger territory sizes, though, he is still constrained to monogamy, even though selection favoring strong pair-bonds is apparently relaxed. Another possibility is that because most coral reef fishes have long dispersive larval stages, they have very open populations. This does not allow for adaptation to local conditions, and, thus, selection favors traits that are, on average, the most adaptive.

Seasonal Variability in Estradiol and Estrone Concentrations in Tissue of the Scleractinian Coral *Montipora verrucosa*[25]

ANN M. TARRANT,[26] SHANNON ATKINSON,[27] and MARLIN J. ATKINSON[27]

Sexual reproduction in scleractinian corals is affected by light, temperature, and other environmental cues, but no studies have elucidated bioregulation of coral gamete development. Two potent estrogens, estrone (E_1) and estradiol (E_2), were measured in homogenates of tissue and skeleton from *Montipora verrucosa* (Vaughan) over 1 yr. Cores of coral tissue and skeleton were collected monthly throughout the year and weekly in July and August. Estrogens were extracted in diethyl ether, purified via celite chromatography, and assayed using radioimmunoassays. Nonspecific binding was measured directly in coral samples and varied with sample weight. Monthly mean E_1 ranged from 20 to 70 ng E_1/g ash-free dry weight (AFDW), with highest values in April. Smaller peaks occurred in early July, before the spawning, although asynchrony in spawning may have obscured trends in the July data. E_2 ranged from 8 to 25 pg E_2/g AFDW, and the highest values occurred in February and March. Peaks in E_2 preceded peaks in E_1, indicating metabolism of a pool of estrogen. Estrogen peaks in spring and early July indicate that estrogens may help to regulate gametogenesis and spawning. Peaks in E_1 coincided with peaks in protein, which is consistent with a role of estrogens in protein synthesis.

Changes in *Tetragnatha* Spider Diversity across a Habitat Boundary[28]

AMY VANDERGAST[29]

The abrupt fragmentation of an area of undisturbed forest causes microclimatic changes at the perimeter of the newly created patches. These edge effects have been shown to cause changes in the biotic community for estimated distances of 40 to 100 m into a forest patch. This range of distance estimates is based on studies of neotropical and temperate areas deforested for agricultural uses, where the influxes of nonnative species and pollutants associated with man-made frag-

[25] Supported by an NDSEG Fellowship and the Pauley Foundation.

[26] Department of Oceanography, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822.

[27] Hawai'i Institute of Marine Biology, Kāne'ohe, Hawai'i 96744.

[28] Financial support for this project provided by the Evolution, Ecology, and Conservation Biology Program, University of Hawai'i at Mānoa.

[29] Department of Zoology, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsors: Rosemary Gillespie and George Roderick.

ments can confound the natural changes caused by the formation of this new boundary. In Hawai'i, natural fragmentation of forested areas caused by lava flows allows for the opportunity to study fragmentation patterns without these confounding factors. The goals of this study were to spatially define the edge ecotone between lava and native Hawaiian forest habitats and to investigate the response of a community of native predators, *Tetragnatha* spiders, to this habitat gradient. I measured plant and spider diversity across the lava to the forest edge in five isolated forest patches of similar size, elevation, and forest type on an 1855 lava flow from Mauna Loa Volcano on the island of Hawai'i. The results of this sampling suggest that an "edge" ecotone of approximately 22 m surrounds core forest habitat and that the spider community structure changes across this boundary, with an overall decrease in species richness and diversity from the core forest and edge habitats to the lava flow, and that cursorial (non web-building) species are found in significantly higher numbers in the core and edge habitats than on the lava flow. This implies that populations of *Tetragnatha* species with habitat ranges that are limited to the interior of the patches are isolated from one another. Depending on the dispersal ability of each species, they may be more prone to extinction in individual fragments because of demographic and environmental stochastisity, as predicted by Gilpin and Soule's D-Vortex model. This isolation may also lead to genetic divergence among populations and, ultimately, speciation.

Biology, Fisheries, and Management of Two Small Pelagic Carangids, *Selar crumenopthalmus* and *Decapterus macarellus*[30]

KEVIN C. WENG[31]

Selar crumenopthalmus Bloch (*akule*) and *Decapterus macarellus* Cuvier ('*ōpelu*) have circumtropical distribution, and fisheries for these species are important throughout this range. Both the '*ōpelu* and the *akule* have high fecundity and very high rates of growth, spawn annually in the nearshore waters of Hawai'i, and have an offshore pelagic larval phase, after which the juveniles migrate inshore. In Hawai'i, the fisheries for '*ōpelu* and *akule* are among the most productive nearshore fisheries in the state. Concerns of overfishing have been raised by the Western Pacific Regional Fisheries Management Council, which this study seeks to address. The Division of Aquatic Resources (Hawai'i) has a 30-yr time series of catch and effort data for these species, which was used to calculate catch per unit effort (CPUE) for the period 1966 to 1995. CPUE is used as an indicator of stock abundance, thus providing an approximate measure of the status of the fishery. Results indicate that there is not a strong decreasing trend in CPUE, and therefore no strong evidence for overfishing. Future work includes the analysis of correlations between CPUE and physical oceanographic indices. The peak cross-correlation function between sea surface temperature (SST) and *akule* CPUE occurs for CPUE lagged 2 yr after SST. This is thought to be modal life cycle length for this species, and therefore such a correlation may be caused by the climatic mediation of recruitment success.

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[31] Department of Oceanography, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822. Sponsor: John R. Sibert.